Class-XII Session 2022-23
Subject - Chemistry
Sample Question Paper - 20
With Solution

BLUE PRINT

S. No.	Chapter Name	Section-A		Section-B		Section-C		Section-D		Section-E		Total Marks
		(MCQs & A/R) 1 Mark		(VSA) 2 Marks		(SA) 3 Marks		(Case Study) 4 Marks		(LA) 5 Marks		
		Q. No.	Marks	Q. No.	Marks	Q. No.	Marks	Q. No.	Marks	Q. No.	Marks	
1	Solutions		0			28. a, b	3	32	4			7
2	Electrochemistry	5	1	23	2					33	5	8
3	Chemical Kinetics	4, 6, 12	3	19, 24	4							7
4	d -and f -Block Elements	3, 13, 17	3							35	5	8
5	Coordination Compounds	8	1	22	2	27. a, b, c	3					6
6	Haloalkanes and Haloarenes	2	1	21	2	26. b, 30. a, b	4					7
7	Alcohols, Phenols and Ethers	1, 9, 15	3	25	2	26. a	1					6
8	Aldehydes, Ketones and Carboxylic Acids	11, 14	2			26. b	1			34	5	8
9	Amines	7, 10, 18	3			29. a, b, c, d	3					6
10	Biomolecules	16	1	20	2			31	4			7
	Total Marks (Total Questions)	18	18	7	14	5	15	2	8	3	15	70

Time : 3 Hours **Max. Marks : 70**

General Instructions

Read the following instructions carefully

(a) *There are 35 questions in this question paper with internal choice.*

(b) *SECTION A consists of 18 multiple-choice questions carrying 1 mark each.*

(c) *SECTION B consists of 7 very short answer questions carrying 2 marks each.*

(d) *SECTION C consists of 5 short answer questions carrying 3 marks each.*

(e) *SECTION D consists of 2 case- based questions carrying 4 marks each.*

(f) *SECTION E consists of 3 long answer questions carrying 5 marks each.*

(g) ***All questions are compulsory.***

(h) ***Use of log tables and calculator are not allowed.***

SECTION-A

The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.

1. An ether is more volatile than an alcohol having the same molecular formula. This is due to
(a) dipolar character of ethers
(b) alcohols having resonance structures
(c) inter-molecular hydrogen bonding in ethers
(d) inter-molecular hydrogen bonding in alcohols

2. When two halogen atoms are attached to same carbon atom then it is :
(a) *vic*-dihalide (b) *gem*-dihalide (c) α, ω-halide (d) α, β-halide

3. The transition element which shows the highest oxidation state is:
(a) Iron (b) Vanadium (c) Manganese (d) Chromium

4. Which option is valid for zero order reaction?
(a) $t_{1/2} = \frac{3}{2} t_{1/4}$ (b) $t_{1/2} = \frac{4}{3} t_{1/4}$ (c) $t_{1/2} = 2t_{1/4}$ (d) $t_{1/4} = (t_{1/4})^2$

5. Based on the cell notation for a spontaneous reaction, at the anode
$Ag(s) | AgCl(s) | Cl^-(aq) || Br^-(aq) | Br_2(l) | C(s)$
(a) AgCl gets reduced (b) Ag gets oxidized (c) Br^- gets oxidized (d) Br_2 gets reduced

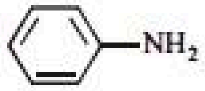
6. $3A \rightarrow 2B$, rate of reaction $\frac{d[B]}{dt}$ is equal to
(a) $-\frac{3}{2}\frac{d[A]}{dt}$ (b) $-\frac{2}{3}\frac{d[A]}{dt}$ (c) $-\frac{1}{3}\frac{d[A]}{dt}$ (d) $+2\frac{d[A]}{dt}$

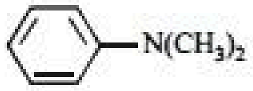
7. Secondary amines could be prepared by:
(a) Reduction of nitriles
(b) Hoffmann bromamide reaction
(c) Reduction of amides
(d) Reduction of isonitriles

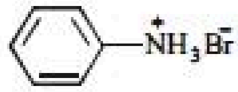
8. Which of the following does not have optical isomer?
(a) $[Co(NH_3)_3Cl_3]$ (b) $[Co(en)_3]Cl_3$ (c) $[Co(en)_2Cl_2]Cl$ (d) $[Co(en)(NH_3)_2Cl_2]Cl$

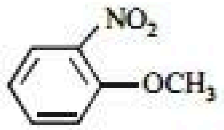
9. Isopropyl alcohol is obtained by reacting which of the following alkenes with concentrated H_2SO_4 followed by boiling with H_2O?
(a) Ethylene (b) Propylene (c) 2-Methylpropene (d) Isoprene

10. End product (A) of the following sequence of reactions is :

(a) 

(b) 

(c) 

(d) 

11. Carbonyl compounds undergo nucleophilic addition because of
   (a) electronegativity difference of carbon and oxygen atoms.
   (b) electromeric effect.
   (c) more stable anion with negative charge on oxygen atom and less stable carbonium ion.
   (d) none of the above.

12. The rate constant for a first order reaction whose half life is 480 sec, is :
   (a) 1.44×10^{-3} sec^{-1} (b) 1.44 sec^{-1} (c) 0.72×10^{-3} sec^{-1} (d) 2.88×10^{-3} sec^{-1}

13. Chloro compound of vanadium has only spin magnetic moment of 1.73 BM. This vanadium chloride has the formula:
   (a) VCl_2 (b) VCl_4 (c) VCl_3 (d) VCl_5

14. A compound that gives a positive iodoform test is
   (a) 1-pentanol (b) 2-pentanone (c) 3-pentanone (d) pentanal

In the following questions (15-18) a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.
(b) Both assertion and reason are correct statements, but reason is not the correct explanation of the assertion.
(c) Assertion is correct, but reason is wrong statement.
(d) Assertion is wrong, but reason is correct statement.

15. **Assertion:** *ter*-butyl methyl ether is not prepared by the reaction of *ter*-butyl bromide with sodium methoxide.
   Reason: Sodium methoxide is a strong nucleophile.

16. **Assertion :** Alpha (α)-amino acids exist as internal salt in solution as they have amino and carboxylic acid groups near vicinity.
   Reason : H^+ ion given by carboxylic group (–COOH) is captured by amino group ($-NH_2$) having lone pair of electrons.

17. **Assertion:** Cuprous ion (Cu^+) is colourless whereas cupric ion (Cu^{2+}) is blue in the aqueous solution.
   Reason: Cuprous ion (Cu^+) has unpaired electrons while cupric ion (Cu^{2+}) does not.

18. **Assertion:** Reduction of *m*-dinitrobenzene with ammonium sulphide gives *m*-nitroaniline.
   Reason: *m*-Nitroaniline formed gets precipitated and hence further reduction is prevented.

SECTION-B

This section contains 7 questions with internal choice in two questions. The following questions are very short answer type and carry 2 marks each.

19. The reaction, $SO_2Cl_2 \longrightarrow SO_2 + Cl_2$, is a first order gas reaction with $k = 2{\cdot}2 \times 10^{-5}$ sec^{-1} at 320 °C. What percentage of SO_2Cl_2 is decomposed on heating this gas for 90 minutes? (Antilog .05158 = 1.126)

20. Name the chemical components which constitute nucleotides. Write any two functions of nucleotides in a cell.

OR

   Define the following terms:
   (i) Glycosidic linkage (ii) Invert sugar

21. Complete the following reactions (giving major products):
   (a) $CH_3CH_2COOAg \xrightarrow{Br_2} ? \xrightarrow{Alc.KOH} ?$ (b) $CH_3CHBrCH_3 \xrightarrow{Alc.KOH} ? \xrightarrow[Peroxide]{HBr} ?$

22. A coordination compound having formula $CoCl_3.4NH_3$ does not liberate ammonia but precipitates chloride ion as AgCl. Give IUPAC name of the complex and write its structural formula.

OR

   Why only transition metals are known to form π complexes?

23. Give reason :
   (a) Rusting of iron pipe can be prevented by joining it with a piece of magnesium.
   (b) Conductivity of an electrolyte solution decreases with the decrease in concentration.

24. The following values for the first order rate constant were obtained in a reaction :
   $T_1 = 298$ K, $k_1 = 3{\cdot}5 \times 10^{-5} s^{-1}$, $T_2 = 308$ K, $k_2 = 14{\cdot}0 \times 10^{-5} s^{-1}$. What is E_a of reaction?

25. Show how will you prepare
   (a) 1-phenylethanol from a suitable alkene.
   (b) cyclohexylmethanol using an alkyl halide by an S_N2 reaction.

SECTION-C

This section contains 5 questions with internal choice in two questions. The following questions are short answer type and carry 3 marks each.

26. (a) Give a chemical test to distinguish 1-propanol and 2-propanol.
(b) Why is $CHCl_3$ not used as an anaesthetic agent these days?
(c) Which of the stronger acid between α-Chloro propanoic acid and β-Chloro propanoic acid

27. $CoSO_4Cl.5NH_3$ exists in two isomeric forms 'A' and 'B'. Isomer 'A' reacts with $AgNO_3$ to give white precipitate, but does not react with $BaCl_2$. Isomer 'B' gives white precipitate with $BaCl_2$ but does not react with $AgNO_3$. Answer the following questions.
(a) Identify 'A' and 'B' and write their structural formulas.
(b) Name the type of isomerism involved.
(c) Give the IUPAC name of 'A' and 'B'.

28. In a cold climate, water gets frozen causing damage to the radiator of a car. Ethylene glycol is used as an antifreezing agent. Calculate the amount of ethylene glycol to be added to 4 kg of water to prevent it from freezing at –6°C.
(K_f for water = 1.85 K mole^{-1} kg)

29. Write the missing product (s) in **any 3** of the following reactions.

(a) $C_6H_5N_2Cl + KI \longrightarrow$

(b) $C_6H_5NH_2 \xrightarrow{Br_2/H_2O}$

(c) $C_6H_5NH_2 \xrightarrow{(CH_3CO)_2O}$

(d) $C_6H_5NH_2 \xrightarrow{HCl}$

30. (a) What is the decreasing order of reactivity of the following in S_N2 reaction?
1-Bromo-2-methylbutane, 1-Bromo-2, 2-dimethylpropane, 1-Bromopentane.
(b) Arrange the compounds CH_3F, CH_3I, CH_3Br, CH_3Cl in order of increasing reactivity in bimolecular nucleophilic substitution (S_N2) reactions.

OR

Explain why :
(a) Allyl chloride is hydrolysed more readily than n-propyl chloride?
(b) Vinyl chloride is hydrolysed more slowly than ethyl chloride?
(c) Chloroform ($CHCl_3$) is a compound of chlorine but it does not give white precipitate with $AgNO_3$?

SECTION-D

The following questions are case-based questions. Each question has an internal choice and carries 4 (1+1+2) marks each. Read the passage carefully and answer the questions that follow.

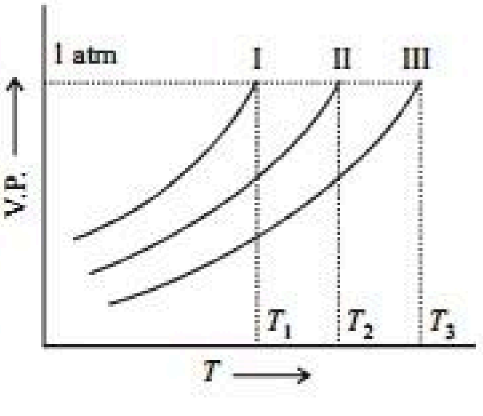
31. Mild oxidizing agents, e.g. bromine water, Tollen's reagent, Fehling's solution etc., oxidize aldoses into aldonic acids. Both glucose and fructose can be oxidized by Tollen's reagent and Fehling's solution despite the presence of a keto group in fructose. Strong oxidizing agents like conc. HNO_3 oxidize glucose to a diabasic acid. Fructose under similar conditions is also oxidized. All carbohydrates are quantitatively oxidized by lead tetraacetate or periodic acid. This reaction is used to elucidate the structure of carbohydrates. Both glucose and fructose can be reduced by red P/HI, $LiAlH_4$, Clemmensen and Wolff-Kishner reduction.
Answer the following questions :
(a) What is number of moles of lead tetraacetate required to oxidize 100 mL of 0.1M fructose solution?
(b) What are the products of oxidation of fructose with conc. HNO_3?
(c) What is the basicity of acid produced by oxidation of glucose with conc. HNO_3?

OR

Name two reagents used for reduction of both glucose and fructose.

32. Vapour pressure of a liquid is the function of temperature. On increasing temperature, greater number of liquid molecules acquire kinetic energy sufficient to overcome the molecular attractions and pass into the vapour state. Hence vapour pressure increases, with increase in temperature, to a limiting value equal to the external pressure, usually 1 atmosphere in an open vessel. The corresponding temperature also attains a limiting value so long external pressure is fixed. However the vapour pressure of a liquid is altered on adding a foreign substance soluble in the former, it may be raised or lowered.

Vapour pressure-temperature plots for pure water, 0.5 m glucose and 0.5 m methanol are depicted in the figure as shown.



Answer the following questions :

(a) What will be the change in vapour pressure of a liquid by adding non-volatile solute?

(b) Which plot represents methanol and why?

(c) Boiling point of methanol is less than water. why?

OR

What is the elevation of boiling point of glucose solution in terms of T_1, T_2 and T_3?

SECTION-E

The following questions are long answer type and carry 5 marks each. Two questions have an internal choice.

33. (a) Consider a cell composed of the following two half-cells:

(i) $Mg(s)|Mg^{2+}(aq)$, and (ii) $Ag(s)|Ag^{+}(aq)$.

The emf of the cell is 2·96 V when $[Mg^{2+}] = 0{\cdot}130$ M and $[Ag^{+}] = 1{\cdot}0 \times 10^{-4}$ M. Calculate the standard emf of the cell. ($R = 8{\cdot}31\ JK^{-1}\ mol^{-1}$, $F = 96500\ C\ mol^{-1}$).

(b) Can we use a copper vessel to store 1 M $AgNO_3$ solution? $E_{Cu^{2+}/Cu} = +0 \cdot 34$ V, $E_{Ag^{+}/Ag} = 0 \cdot 80$

OR

(a) Explain why electrolysis of aqueous solution of NaCl gives H_2 at cathode and Cl_2 at anode. Write overall reaction.

$E^{\circ}_{Na^{+}/Na} = -2{\cdot}71V$, $E^{\circ}_{H_2O/H_2} = -0{\cdot}83V$, $E^{\circ}_{Cl_2/Cl^{-}} = +1{\cdot}36V$, $E^{\circ}_{O_2/H_2O} = +1{\cdot}23V$

(b) What happens when I_2 and F_2 are added to a solution containing 1M each of I^- and F^- ions.
Given: Reduction potentials of I_2 and F_2 are 0·54 volt and 2·87 volts respectively.

34. How will you convert

(a) Ethanal to lactic acid

(b) Ethanol to butan-2-one

(c) Acetone to *tert*-butyl alcohol

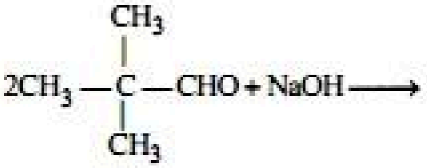
(d) Propene to propanone

(e) Benzaldehyde to benzophenone.

OR

(a) Complete the following reactions :

(i) $6HCHO + 4NH_3 \xrightarrow{Heat}$

(ii) 

$2CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-CHO + NaOH \longrightarrow$

(b) Give reasons for the following :

(i) Dialkyl cadmium is used to prepare ketones from acid chlorides and not from Grignard reagents.

(ii) Hydrazones of aldehydes and ketones are not prepared in strongly acidic medium.

35. (a) (i) Which of the following oxides in basic: V_2O_5 or CrO_3?

(ii) What is most stable oxidation state of Ti (Z = 22) is aqueous solution?

(iii) Why is copper sulphate pentahydrate coloured?

(b) Explain why

(i) E° for Mn^{3+}/Mn^{2+} couple is more positive than that for Fe^{3+}/Fe^{2+}.
[Atomic numbers of Mn = 25, Fe = 26]

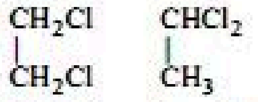
(ii) Ce^{3+} can be easily oxidised to Ce^{4+}. [Atomic number of Ce = 58]

SOLUTIONS

SAMPLE PAPER-1

1. **(d)** Due to inter-molecular hydrogen bonding in alcohols boiling point of alcohols is much higher than ether.

2. **(b)**



$$\underset{CH_2Cl}{\overset{CH_2Cl}{|}} \qquad \underset{CH_3}{\overset{CHCl_2}{|}}$$

(*vic*-dihalide) (*gem*-dihalide)

3. **(c)** Among the green elements, manganese has the highest oxidation state of + 7 in $KMnO_4$. Chromium, vanadium and iron has the highest oxidation state of +6 ($K_2Cr_2O_7$), +5 (V_2O_5) and +3 (Fe_2O_3) respectively. (1 mark)

4. **(c)** For zero order,

$A = A_0 - kt$

$$t_{1/2} = \frac{A_0}{2k}$$

$$t_{1/4} = \frac{A_0}{4k}$$

$$\frac{t_{1/2}}{t_{1/4}} = \frac{2}{1}$$

5. **(b)** Ag gets oxidized at anode and Br^- gets reduced at cathode.

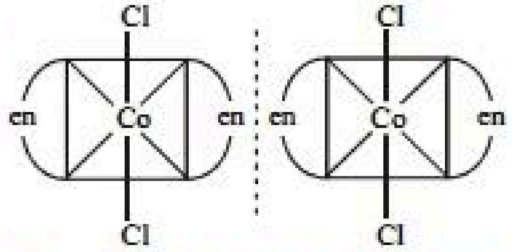
6. **(b)** $3A \longrightarrow 2B$

Rate of appearance of B is equal to rate of disappearance of A.

$$\frac{1}{2}\frac{d[B]}{dt} = -\frac{1}{3}\frac{d[A]}{dt} \Rightarrow \frac{d[B]}{dt} = -\frac{2}{3}\frac{d[A]}{dt} \qquad \text{(1 mark)}$$

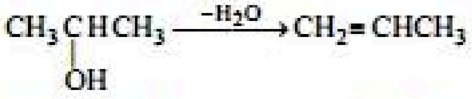
7. **(d)** $\underset{\text{Alkyl isocyanide}}{R-N\equiv C} \xrightarrow{4[H]} \underset{\text{Secondary amine}}{RNH-CH_3}$

8. **(c)**



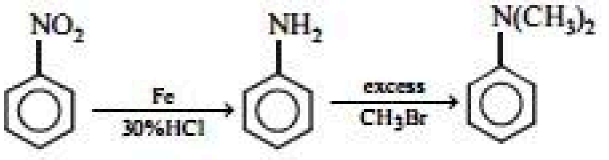
In complex (c), the mirror image is superimposable. So, they are not different compounds.

9. **(b)** Since the compound is formed by hydration of an alkene, to get the structure of alkene remove a molecule of water from the alcohol.



$$\underset{\text{Isopropyl alcohol}}{CH_3\underset{\underset{OH}{|}}{C}HCH_3} \xrightarrow{-H_2O} \underset{\text{Propylene}}{CH_2=CHCH_3}$$

10. **(b)**



11. **(c)**

12. **(a)** $k = \frac{0.693}{t_{1/2}} = \frac{0.693}{480} = 1.44 \times 10^{-3} s^{-1}$

13. **(b)** $\mu = \sqrt{n(n+2)}$

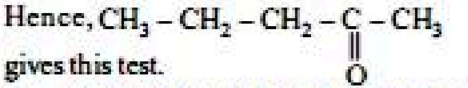
$1.73 = \sqrt{n(n+2)} \Rightarrow n = 1$

No. of unpaired electrons = 1, hence its configuration will be, V(23) = $[Ar]\,3d^3 4s^2$

$V^{4+} = [Ar]3d^1 4s^0$

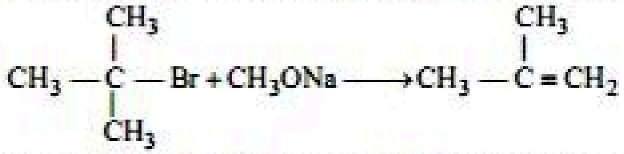
∴ Its chloride has the formula VCl_4.

14. **(b)** Compounds having $-\overset{\overset{O}{\|}}{C}-CH_3$ group show positive iodoform.



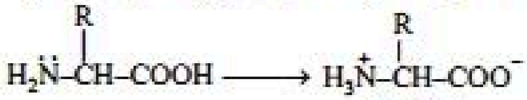
Hence, $CH_3-CH_2-CH_2-\underset{\underset{O}{\|}}{C}-CH_3$ (pentanone-2) gives this test.

15. **(b)** *ter*-butyl bromide and sodium methoxide reacts to form 2-methylpropene and ethanol (elimination reaction).



$$CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-Br + CH_3ONa \longrightarrow CH_3-\overset{\overset{CH_3}{|}}{C}=CH_2$$

16. **(a)** α-amino acids have a basic–NH_2 group and an acidic–COOH group. In neutral solution they exists as an internal salt which is also called as zwitter ion. This zwitter ion is formed due to the reason that proton of –COOH group is captured by –NH_2 group having lone pair of electrons.



$$H_2\ddot{N}-\overset{\overset{R}{|}}{C}H-COOH \longrightarrow \underset{\substack{\text{zwitter ion}\\\text{(dipolar ion)}}}{H_3\overset{+}{N}-\overset{\overset{R}{|}}{C}H-COO^-}$$

17. **(c)** Cu^+ (cuprous ion) does not have any unpaired electron while cupric ion (Cu^{2+}) has one unpaired electron in 3*d* shell.

$Cu^+ = 3d^{10}4s^0$; $Cu^{2+} = 3d^9 4s^0$

Cu^+ is colourless because it does not have any unpaired electron but Cu^{2+} ion is blue in aqueous solution due to the formation of complex with water molecules.

18. (c) The correct reason is : The overall electron deficiency in *m*-nitroaniline is much less (due to –R effect of NO_2 group and +R effect of NH_2 group) than in *m*-dinitrobenzene (–R effect of the two NO_2 groups) and hence does not accept additional electrons from a weak reducing agent such as $(NH_4)_2S$ and thus further reduction is prevented.

19. $k = 2{\cdot}2 \times 10^{-5}\ \text{sec}^{-1}$, t = 90 min = 90 × 60 = 5400 sec.

$$k = \frac{2{\cdot}303}{t} \log \frac{a}{(a-x)} \qquad (½\ \text{mark})$$

$$2{\cdot}2 \times 10^{-5} = \frac{2{\cdot}303}{5400} \log \frac{a}{(a-x)}$$

$$\log\left(\frac{a}{a-x}\right) = \frac{2{\cdot}2 \times 10^{-5} \times 5400}{2{\cdot}303} = 0{\cdot}05158 \qquad (½\ \text{mark})$$

Taking antilog of both the sides, we get

$$\frac{a}{a-x} = 1{\cdot}126$$

$$a = 1{\cdot}126\,a - 1{\cdot}126\,x$$

$$x = \frac{0{\cdot}126}{1{\cdot}126}\,a = 0{\cdot}1119a$$

If a = 100 then x = 0·1119 × 100 = 11·19

Hence, the percentage decomposition of SO_2Cl_2 = 11·19 % (1 mark)

20. Chemical components of nucleotides are

(a) a nitrogenous base (purine or pyrimidine)

(b) a pentose sugar (ribose or 2-deoxyribose)

(c) a phosphoric acid group. (1 mark)

Functions of nucleotides:

(a) Nucleotides are precursors of nucleic acids in the cell.

(b) They are source of chemical energy, viz. ATP (adenosine triphosphate) and ADP (adenosine diphosphate). (1 mark)

OR

(i) **Glycosidic linkage:** A linkage between two monasaccharide units through O-atom is called glycosidic linkage. It is formed when two monosaccharide units are joined together through an ethereal or oxide linkage by loss of a H_2O molecule. (1 mark)

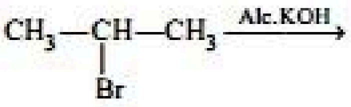
(ii) **Invert sugar:** An equimolar mixture of glucose and fructose is called invert sugar. (1 mark)

21. (a)

$$CH_3CH_2COOAg \xrightarrow{Br_2} CH_3CH_2Br \xrightarrow[KOH]{Alk.} CH_2 = CH_2$$

1-Bromoethane Ethene (1 mark)

(b)



$$CH_3-\underset{\underset{Br}{|}}{CH}-CH_3 \xrightarrow{Alc.KOH}$$

2-Bromopropane Propane

$$CH_3-CH=CH_2 \xrightarrow[peroxide]{HBr} CH_3-CH_2-CH_2-Br$$

1-Bromopropane (1 mark)

22. Coordination number of cobalt is 6. NH_3 and Cl both are monodenate ligand. From the given information, it is clear that cobalt is in + 3 oxidation state and forms coordination sphere with four NH_3 and two Cl^- and third Cl^- forms ionisation sphere, *i.e.*, formula of complex is $[Co(NH_3)_4Cl_2]$ Cl. (1 mark)

Its IUPAC name is tetrammine dichlorido cobalt (III) chloride. (1 mark)

OR

Transition metals/ions have empty *d*-orbitals into which the electron pairs can be accomodated which are donated by ligands containing π-electrons, *e.g.*, $CH_2 = CH_2$, C_5H_5, C_6H_6, etc. The presence of empty *d*-orbitals in the transition metal enables them to form π-complexes. (2 marks)

23. (a) This occurs due to the cathodic protection in which magnesium metal is oxidised (or corroded) in preference to iron since its reduction potential is lower. It acts as anode and protects iron from getting rusted.

$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s);\ E^\circ = -2.37\ V$

$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s);\ E^\circ = -0.44\ V$ (1 mark)

(b) With decrease in the concentration or upon dilution, the number of ions present per unit volume of the solution also decrease. As a result, the conductivity of the soluton decreases. (1 mark)

24.

$$\log\frac{k_2}{k_1} = \frac{E_a}{2{\cdot}303\ R}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$$

$$E_a = \frac{2{\cdot}303\ R \times T_1 T_2}{T_2 - T_1} \log \frac{k_2}{k_1} \qquad (½\ \text{mark})$$

$$= \frac{2\cdot 303 \times 8\cdot 314 \times 298 \times 308}{308 - 298} \log \frac{14 \times 10^{-5}}{3.5 \times 10^{-5}} \qquad (½\ \text{mark})$$

$$= 175740{\cdot}12 \log 4 = 175740{\cdot}12 \times 0{\cdot}6020$$

$$= 105795\ J = 105{\cdot}795\ kJ. \qquad (1\ \text{mark})$$

25. (a) Addition of H_2O to ethenylbenzene (styrene) is presence of dil. H_2SO_4.

(1 mark)

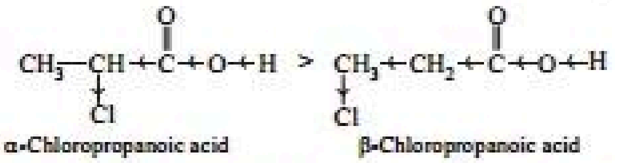
(b) Hydrolysis of cyclohexylmethyl bromide by aqueous NaOH gives cyclohexylmethanol.

(1 mark)

26. (a) Lucas regent (anhyd. $ZnCl_2$ + HCl) is added to both and shaken. 2-propanol produces cloudiness in about 3-5 minutes at room temperature while 1-propanol does not give cloudiness even after a long time at room temperature. (1 marks)

(b) It is because of the poisonous substance (phosgene) which is formed due to its reaction with air in presence of light. (1 mark)

(c)



$CH_3-CH(Cl)-COOH > CH_2(Cl)-CH_2-COOH$

α-Chloropropanoic acid β-Chloropropanoic acid

Electron withdrawing effect (– I effect) decrease with increase in distance of electron withdrawing group from carboxyl group. (1 mark)

27. (a) A - $[Co(NH_3)_5SO_4]Cl$ (1 mark)
B - $[Co(NH_3)_5Cl]SO_4$ (1 mark)
(b) Ionisation isomerism (½ mark)
(c) IUPAC name of A is Pentaamminesulphatocobalt (III) chloride, IUPAC name of B is Pentaammine chlorocobalt (III) sulphate. (½ mark)

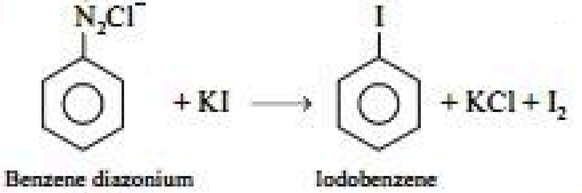
28. $K_f = 1.85$ K mol^{-1} kg, $\Delta T_f = 6$K, $m = 62$,
$W = 4$ kg $= 4 \times 10^3$ g, w = wt. of solute

Now we know that $\Delta T_f = \dfrac{1000 \times K_f \times w}{W \times m}$

$$6 = \frac{1000 \times 1.85 \times w}{4 \times 10^3 \times 62}$$

On usual calculations, $w = 804.32$ g (3 marks)

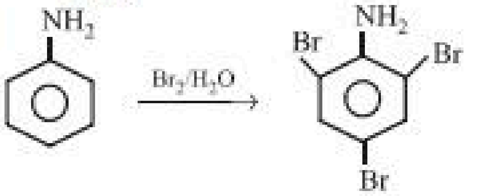
29. (a)



Benzene diazonium chloride Iodobenzene

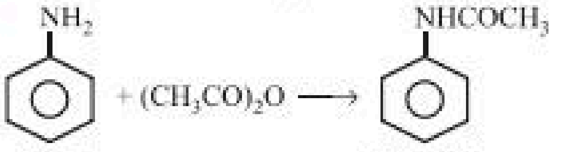
(1 mark)

(b)



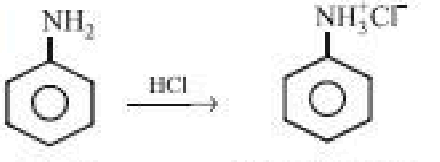
Aniline 2,4,6-Tribromoaniline (1 mark)

(c)



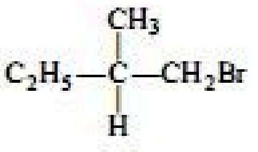
Aniline Acetanilide (1 mark)

(d)



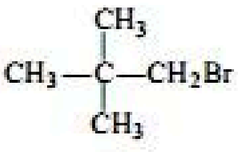
Aniline Anilinium chloride (1 mark)

30. (a) All are primary alkyl halides and their structural formulae are:



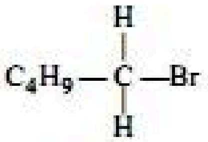
$C_2H_5-C(CH_3)(H)-CH_2Br$

(I)



$CH_3-C(CH_3)_2-CH_2Br$

(II)



$C_4H_9-CH_2-Br$

(III)

The order of reactivity is : (III) > (I) > (II) (½ mark)

The S_N2 reactions are sensitive to steric hindrance. Greater the steric hindrance to the attacking nucleophile, lesser will be the reactivity. (1 mark)

(b) $CH_3F < CH_3Cl < CH_3Br < CH_3I$ (½ mark)

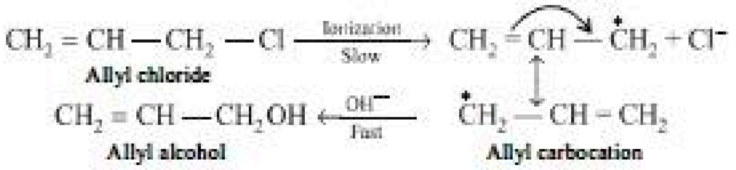
In the nucleophilic substitution reactions, the nucleophile is to displace the halide ion (X^-). Greater the bond dissociation enthalpy of the C—X bond, lesser will be the reactivity. The order of bond dissociation enthalpy of different C—X bond is

C — F > C — Cl > C — Br > C — I

The order of reactivity towards S_N2 reactions is the reverse. (1 mark)

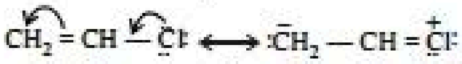
OR

(a) Allyl chloride readily undergoes ionization to produce resonance stabilized allyl carbocation. Since carbocations are reactive species, therefore, allyl cation readily combines with OH^- ions to form allyl alcohol. Corresponding formation of n-propyl carbocation is not easy because of its less stability. So, n-propyl chloride does not hydrolyse easily.



(1 mark)

(b) Vinyl chloride may be represented as a resonance hybrid of the following two structures:



$CH_2=CH-\ddot{\underset{..}{Cl}}: \longleftrightarrow :\bar{C}H_2-CH=\overset{+}{\underset{..}{Cl}}:$

As a result of resonance, the carbon-chlorine bond acquires some double bond character. In contrast, in ethyl chloride the carbon-chlorine bond is a pure single bond. Thus, vinyl chloride undergoes hydrolysis more slowly than ethyl chloride. (1 mark)

(c) This is because in $CHCl_3$ all the three chlorine atoms are bonded to carbon atom by covalent bonds and there is no free chloride ions. $AgNO_3$ gives white precipitate when free chloride ions are present in solution. (1 mark)

31. (a) 0.05 [1 molecule will require 5 molecules of HIO_4. Hence 10^{-2} moles will require 5×10^{-2} moles of HIO_4.] (1 mark)
(b) Tartaric and glycolic acid. (1 mark)
(c) Glucose on oxidation with conc. HNO_3 produces dibasic acid, So, basicity will be two. (2 mark)

OR

Red P/ HI and $LiAlH_4$ can be used for reduction of both glucose and fructose. (2 mark)

32. (a) By adding nonvolatile solute vapour pressure of the solution dcrease. (1 mark)

(b) Plot I because methanol is a volatile compound. (1 mark)

(c) Because methanol is more volatile than water. (2 marks)

OR

$T_3 - T_2$ (2 marks)

33. (a) Mg is more electropositive than Ag, so the cell is Mg $|Mg^{2+}||Ag^+(aq)|$ Ag.

The net cell reaction is given by,

$Mg + 2Ag^+ \longrightarrow Mg^{2+} + 2Ag$ (½ mark)

Here $n = 2$ (½ mark)

The Nernst equation for this cell is,

$$E_{cell} = E^\circ_{cell} - \frac{2\cdot303\,RT}{nF}\log\frac{[Mg^{2+}]}{[Ag^+]^2} \quad \text{(½ mark)}$$

$$2\cdot96 = E^\circ_{cell} - \frac{2\cdot303\times8\cdot31\times298}{2\times96500}\log\frac{0\cdot130}{(1\times10^{-4})^2} \quad \text{(½ mark)}$$

$$\therefore\ E^\circ_{cell} = 2\cdot96 + \frac{2\cdot303\times8\cdot31\times298}{2\times96500}\log\frac{0\cdot130}{(1\times10^{-4})^2} \quad \text{(½ mark)}$$

$$= 2\cdot96 + 0\cdot0295\times7\cdot114 = 2\cdot96 + 0\cdot21$$

$E^\circ_{cell} = 3\cdot17$ V. (½ mark)

(b) No, we cannot use a copper vessel to store $AgNO_3$ solution. This is because the reduction potential of Ag^+/Ag electrode is higher than that of Cu^{2+}/Cu electrode, *i.e.*, copper is more reactive than silver.

$2Ag^+(aq) + Cu(s) \longrightarrow 2Ag(s) + Cu^{2+}(aq)$. (2 marks)

OR

(a) An aqueous solution of NaCl contains Na^+, Cl^-, H^+ and OH^- ions (produced by the dissociation of H_2O). When this solution is electrolysed, the cations (Na^+ and H^+) migrate towards the cathode whereas anions (Cl^- and OH^-) migrate towards the anode.

Since the reduction potential of Na is less than that of H_2, H_2 is reduced in preference to Na at cathode.

$2H_2O\,(l) + 2e^- \longrightarrow H_2\,(g) + 2OH^-$

At anode, the following reactions take place:

$2Cl^-(aq) \longrightarrow Cl_2(g) + 2e^-$; $E^\circ = 1\cdot36$ V

$2H_2O\,(l) \longrightarrow O_2(g) + 4H^+(aq) + 4e^-$; $E^\circ = 1\cdot23$ V

The reaction at the anode with lower value of E° is preferred and water should get oxidised in preference to $Cl^-(aq)$. But $Cl^-(aq)$ is oxidised in preference to H_2O because of over potential of oxygen. (2 marks)

The overall reaction may be written as,

$$NaCl\,(aq) + H_2O\,(l) \longrightarrow Na^+\,(aq) + OH^-\,(aq) + \frac{1}{2}H_2\,(g) + \frac{1}{2}Cl_2\,(g). \quad \text{(1 mark)}$$

(b) Reduction potential, $E^\circ_{I_2,I^-}$ is lower than that of $E^\circ_{F_2,F^-}$. Iodide ion (I^-) will be oxidised and F_2 will be reduced to F^-, *i.e.*, the following reaction will take place:

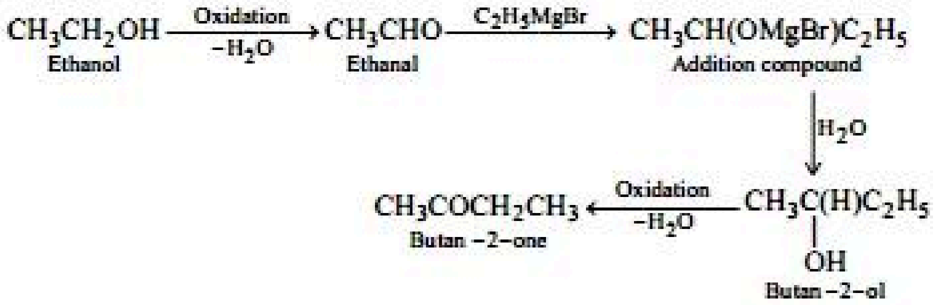
$F_2 + 2I^- \longrightarrow 2F^- + I_2$ (2 marks)

34. (a) Ethanal to lactic acid :

$$\underset{\text{Ethanal}}{CH_3CH=O} \xrightarrow{HCN} \underset{\text{Ethanal cyanohydrin}}{CH_3CH(OH)CN} \xrightarrow{2H_2O/H^+} \underset{\text{Lactic acid}}{CH_3CH(OH)COOH}$$

(1 mark)

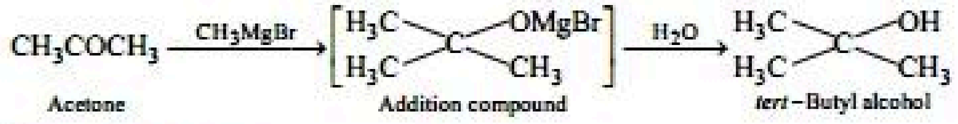
(b) Ethanol to butan-2-one :



$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[-H_2O]{\text{Oxidation}} \underset{\text{Ethanal}}{CH_3CHO} \xrightarrow{C_2H_5MgBr} \underset{\text{Addition compound}}{CH_3CH(OMgBr)C_2H_5} \xrightarrow{H_2O} \underset{\text{Butan-2-ol}}{CH_3C(H)(OH)C_2H_5} \xrightarrow[-H_2O]{\text{Oxidation}} \underset{\text{Butan-2-one}}{CH_3COCH_2CH_3}$$

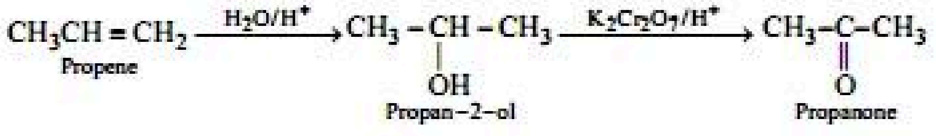
(1 mark)

(c) Acetone to *tert*-butyl alcohol :



(1 mark)

(d) Propene to propanone :



$$\underset{\text{Propene}}{CH_3CH=CH_2} \xrightarrow{H_2O/H^+} \underset{\text{Propan-2-ol}}{CH_3-\underset{OH}{\underset{|}{CH}}-CH_3} \xrightarrow{K_2Cr_2O_7/H^+} \underset{\text{Propanone}}{CH_3-\underset{O}{\underset{\|}{C}}-CH_3}$$

(1 mark)

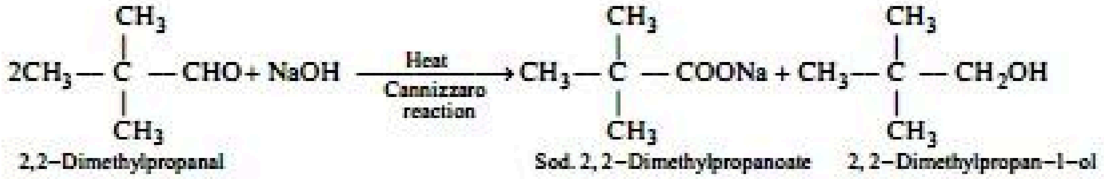
(e) Benzaldehyde to benzophenone :

$$\underset{\text{Benzaldehyde}}{C_6H_5CHO} \xrightarrow{\text{Oxidation}} \underset{\text{Benzoic acid}}{C_6H_5COOH} \xrightarrow[\text{heat}]{Ca(OH)_2} \underset{\text{Cal. benzoate}}{(C_6H_5COO)_2Ca} \xrightarrow{\text{Distill.}} \underset{\text{Benzophenone}}{C_6H_5COC_6H_5}$$

(1 mark)

OR

(a) (i) $\underset{\text{Formaldehyde}}{6HCHO + 4NH_3} \longrightarrow \underset{\text{Urotropine}}{(CH_2)_6N_4} + 6H_2O$ (1 mark)

(ii) 

$$2CH_3-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-CHO + NaOH \xrightarrow[\text{Cannizzaro reaction}]{\text{Heat}} CH_3-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-COONa + CH_3-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-CH_2OH$$

2,2–Dimethylpropanal Sod. 2, 2–Dimethylpropanoate 2, 2–Dimethylpropan–1–ol

(1 mark)

(b) (i) Grignard reagents form ketones with acid chlorides but the reaction does not stop at this stage. Ketones further take part in the reactions with Grignard reagents to give tertiary alcohols. Therefore, dialkyl cadmium is used which reacts with only acid chlorides and not with ketones. (1½ mark)

(ii) Hydrazones are formed by reacting carbonyl compounds with hydrazine $(\ddot{N}H_2-\ddot{N}H_2)$ which acts as a nucleophile. In the strongly acidic medium, hydrazine gets protonated and, therefore, it is not in a position to act as nucleophile. As a result, hydrazones of aldehydes and ketones are not prepared in strongly acidic medium. (1½ mark)

35. (a) (i) None. Both V_2O_5 and CrO_3 are acidic oxides. (1 mark)

(ii) Ti (Z = 22) has electronic configuration $[Ar]^{18}\ 3d^2\ 4s^2$. It shows + 4 as most stable oxidation state in which it (Ti^{4+}) has configuration of argon. (1 mark)

(iii) In copper sulphate pentahydrate, $CuSO_4 \cdot 5H_2O$, Cu^{2+} ion has unpaired electron in 3*d*-orbital. Due to this, Cu^{2+} ion can have *d* – *d* transition when exposed to visible radiation. (1mark)

(b) (i) Mn^{2+} is more stable $\left(4s^0\ 3d^5\right)$, because of half-filled *d*-orbitals than $Mn^{3+}\left(4s^0\ 3d^4\right)$ while $Fe^{3+}\left(4s^0\ 3d^5\right)$ is more stable than $Fe^{2+}\left(4s^0\ 3d^6\right)$ again because of half filled *d*-orbitals. Therefore, Mn^{3+} can be easily reduced to Mn^{2+} whereas Fe^{3+} is not easily reduced to Fe^{2+}, rather Fe^{2+} is more easily oxidised to Fe^{3+}. (1 mark)

(ii) Ce^{4+} is more stable than Ce^{3+} because of stable electronic configuration and higher hydration energy of Ce^{4+}, hence Ce^{3+} is easily oxidised to Ce^{4+}. (1 mark)